

**DUWAMISH/DIAGONAL SEDIMENT REMEDIATION  
DREDGING AND CAPPING OPERATIONS  
SEDIMENT MONITORING  
SAMPLING AND ANALYSIS PLAN**

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**Prepared by the  
King County Department of Natural Resources and Parks  
Water and Land Resources Division**



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**NAME OF PROJECT:** Duwamish/Diagonal Sediment Remediation, Dredging and  
Capping Operation Sediment Monitoring

**PROJECT NUMBER:** 423056 Subproject 80 Phase 003

**SAP PREPARED BY:** King County Department of Natural Resources and Parks  
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## **1. Introduction**

Two Sampling and Analysis Plans (SAPs) will be prepared and submitted to regulatory agencies for approval to address the following monitoring needs specified in the May 2003 monitoring plan for the Duwamish/Diagonal (Du/Di) project. Monitoring dredging and capping depth and measuring chemical levels in various sediments collected before, during, and after construction of the cap is addressed in this SAP. A second SAP will address Water Quality monitoring during construction.

This SAP describes the planned scope of work, field sampling procedures, and laboratory analytical requirements for monitoring sediment chemistry and the dredging and capping depths during construction and post-construction. The discussion contained in the May 2003 monitoring plan provides the specific information used to prepare this detailed Du/Di Sediment Monitoring (Du/Di SM).

The revised and finalized construction and post-construction monitoring plan for the expanded Du/Di sediment remediation was prepared in accordance with the Washington Department of Ecology (Ecology) Sediment Management Standards (Chapter 173-204 WAC). The original monitoring plan was included as Appendix Q of the 2001 Cleanup Study Report and addressed a cleanup area about 5 acres in size (Cleanup Area A) that had a preferred cleanup method of "Capping with no change in existing elevation" (Alternative 3). It was envisioned that the initial monitoring plan in Appendix Q would need to be updated and revised during final design and permitting, but when the project was expanded to include another 2-acres (Cleanup Area B), additional revisions were needed.

The first revision to the monitoring plan was dated January 2003 and responded to comments obtained from both regulatory and public review. After January 2003 regulatory agencies submitted additional comments about the monitoring plan during the permitting process. The monitoring plan was revised and finalized in the document dated May 2003, which addresses all comments received from regulatory agencies during the permit process. The May 2003 monitoring plan have been reviewed and approved by both Ecology and EPA. Ecology is the lead agency that approving the project under MTCA, but both Ecology and EPA have been reviewing project documents because the lower Duwamish River was designated a Superfund site in 2001.

## **2. Project Description**

### **2.1 Project Background**

The primary goal of the Du/Di project is to remediate contaminated sediments in the lower Duwamish River estuary by installing an isolating sediment cap after a layer of contaminated sediment is removed to make room for the cap. The Du/Di sediment cleanup project includes two rectangular cleanup areas, which are located adjacent to each other and total about 7 acres in size. Cleanup Area A is the largest (about 5 acres) and was the first cleanup area identified for remediation. Sediments in both cleanup

areas have concentrations that exceed the state Sediment Quality Standards (SQS) values for PCBs, mercury, bis(2-ethylhexyl)phthalate and butyl benzyl phthalate. Even though cleanup Area B is smaller in size (about 2 acres), this area has the highest PCBs and represents a potential source of PCB recontamination to Area A unless Area B is cleaned up prior to cleaning up Area A. When the project underwent outside review, there were recommendations to include the upstream PCB "hot spot" in the cleanup action so the cleanup site was expanded to include Cleanup Area B.

The cleanup project is being conducted by the King County Department of Natural Resources and Parks (KCDNRP, formerly Metro) on behalf of the Elliott Bay/Duwamish Restoration Program (EBDRP) Panel. The EBDRP Panel selected the Du/Di site as a priority site for cleanup under the EBDRP Sediment Remediation program established by the 1991 consent decree settling a Natural Resources Damages lawsuit. The consent decree stipulates that sediment remediation will be conducted at CSO and storm drain locations owned by the City of Seattle and Metro (now King County). The consent decree also stipulates that cleanup must comply with state Sediment Management Standards (SMS). The Du/Di cleanup project officially started in 1994 under SMS where the Washington State Department of Ecology (Ecology) is the lead agency. Ecology issued the final Cleanup Action Decision Document to approve the project in July 2002.

The Du/Di cleanup project is within the Lower Duwamish Waterway Superfund site that was listed by the U.S. Environmental Protection Agency (EPA) on September 13, 2001. The EPA is the lead agency for Superfund cleanup projects so the Du/Di project is being coordinated with EPA to ensure compliance with Superfund requirements. As part of the Superfund work, both EPA and Ecology have agreed with the plan to identify sites that pose the greatest hazard and start cleanup efforts on these sites as soon as possible. These sites are designated as early-action sites. It was decided that the Du/Di site would be an early-action site because of the elevated PCB, mercury, BEHP, and butyl benzyl phthalate levels and the significant progress made on the cleanup plan since 1994. Ecology and EPA consider the Du/Di project to be a partial cleanup action due to the potential for additional cleanup needs to be identified in the sediments adjacent to the site, which would be addressed at a future time.

Construction work for the Du/Di cleanup project is scheduled to begin with dredging at the beginning of November 2003 and the capping work will be completed by March 1, 2004.

## **2.2 Project Objectives**

The goal of the monitoring plan is to assess the effectiveness of the preferred alternative in maintaining protection of the environment (and related human health) during and after implementation of the cleanup action. Environmental monitoring includes both short-term activities that are limited to the construction period and long-term activities that track conditions at the sediment cap for at least 10 years. Short-term monitoring activities are needed to determine that all dredging and capping activities are performed according to plan specifications and that water quality standards are not exceeded during

construction. The long-term monitoring tracks both the stability of the cap and any recontamination of the cap.

The long term monitoring strategy is to conduct sampling more frequently during the early years after capping and then reduce the frequency of sampling over time. A baseline-sampling event would be conducted within three months of cap placement, and the cap would be sampled each year during the first 5 years after cap completion. The frequency of sampling events during the next 5 years would be determined based on the rate of recontamination observed during the first 5 years of monitoring. If recontamination appears to have stabilized after 5 years, then monitoring could be reduced to alternating years.

There are eight main objectives associated with the monitoring plan as listed below. A summary of the sampling activities and schedule are provided in Table 1 and sampling stations are shown in Figure 1.

OBJECTIVE 1: To insure that water quality standards or guidelines are met during dredging and transport of contaminated sediment to an approved disposal facility (either landfill or nearshore confined disposal).

OBJECTIVE 2: To insure that the dredging and capping constructions are performed according to plan specifications.

OBJECTIVE 3: To identify dredge material that is above the PCB dangerous waste level (50 ppm) so this dredge material can be sent to a TSCA approved landfill.

OBJECTIVE 4: To insure that capping materials (sand and habitat mix) are chemically clean prior to placement.

OBJECTIVE 5: To document whether the dredging of contaminated sediments leads to any increases in chemical levels in sediments located beyond the cleanup site boundary.

OBJECTIVE 6: To document whether chemistry levels in areas beyond the cleanup site boundary are high enough that they could be a source of PCB recontamination to the cap and should be considered for sediment remediation action.

OBJECTIVE 7: To document potential future recontamination of the cap by continuing point source discharges of storm water or combined sewer overflow.

OBJECTIVE 8: To document cap stability for isolating contaminants over time.

## **2.3 Project Area Description**

The Du/Di cleanup area is located at approximately river kilometer 3 in the lower portion of the Duwamish River, within the south industrial section of Seattle, Washington. The cleanup site includes two rectangular cleanup areas that are located on the East Side of

the river (opposite Kellogg Island) near Port of Seattle's terminals T-106 (Cleanup Area A) and T-108 (Cleanup Area B). The combined size totals about 7 acres.

Cleanup Area A is about 5 acres and is located offshore from two discharge pipes. The Duwamish CSO pipe is submerged and is controlled to less than one overflow per year. Stormwater primarily comes out of the Diagonal CSO/SD, which has a large outfall structure along the shoreline. Two parallel sewer lines called the Duwamish Siphon cross the river under Cleanup Area A and were installed in 1967, below the river bottom in a dredged trench. Cleanup Area A extends from the shoreline to the edge of the navigation channel.

Cleanup Area B is about 2 acres in size and is located offshore from an abandoned sewage treatment plant that closed in 1969. Cleanup Area B is on the offshore side of a tie-up loading pier at T-108; therefore, in this area the cap was designed with armor rock to protect it from erosion due to prop wash from tug boats that move barges to and from the pier. Part of Cleanup Area B extends into the navigation channel so over-dredging will be conducted in the area extending into the channel to insure the surface of the cap is at minus 32 feet (MLLW), which is two feet deeper than channel depth of minus 30 feet (MLLW). Cleanup Area B does not extend to the shoreline behind the pier because this area had lower chemical values. In 1977, before the pier was present, the area was dredged to create a deeper berthing area near shore, and a new shoreline was created about 100 feet further inshore from the old shoreline.



**Figure 1. Duwamish/Diagonal Sediment Remediation Area Showing Sediment Sampling Stations.**

Insert figure here

**Table 1 – Sediment Monitoring Activities**

| <b>Activity</b>   | <b>Frequency</b>   |
|---|--|
| Dredging depths during construction                           | One or more surveys after dredging   |
| Cap thickness during construction                             | One or more surveys after capping layers   |
| Dredge material monitoring for PCB's                          | 2-3 samples - one time   |
| Cap material monitoring                                       | One sample each source of sand   |
| Before chemistry beyond site boundary                         | 12 stations once   |
| After chemistry beyond site boundary                          | 12 stations once   |
| Additional sediment chemistry beyond boundary                 | 8 stations once  |
| Long-term monitoring of chemical concentration on cap surface | 5 stations Area A, 3 stations Area B, annually first five years                      |
| Long-term monitoring of cap thickness for stability           | Bottom survey annually first 5 years and possibly less frequently the second 5 years |
| Reports and meetings  | Annual reports and 5 year review meeting   |

### **3.0 Study Objectives**

#### **3.1 Measuring Dredging Depths and Cap Thickness**

Many bottom depth surveys will be conducted during dredging and capping to accomplish Objective 2, which is to insure that the dredging work and construction of the cap and armor layers adheres to the specifications in the dredge and cap plan. Accurate measurements of the dredging depths are required because the payment schedule for the construction contractor is based on the calculated volume of material dredged. King County will conduct detailed bathymetry surveys prior to dredging, after dredging is completed, and at various times during placement of capping and armoring material. In addition, the construction contractor is required to perform daily bottom surveys of work completed and this information will be reviewed daily with King County project inspectors.

If surveys detect deviations from either the dredging or capping plan, the contractor will be required to make corrections, which will be verified by conducting additional bathymetry surveys. The contractor is required to insure dredge cuts are deep enough per the plan; however, to discourage the contractor from dredging beyond the dredge plan depths, the contractor will not be paid for excess material dredged beyond the specified dredge cut depth. When the contractor places capping material, the contractor must achieve the minimum capping depth per the plan specifications, but to prevent the contractor from placing capping material in excess of the specified depth, the contractor will not be paid for any cost associated with placing excess capping material beyond specifications. Also, the contractor will not be paid for costs incurred to remove capping material to meet specifications. Because the thickness of some capping material layers are one-foot, bottom depth surveys will be required to possess the accuracy needed to insure capping layers are correctly installed.

The detailed bathymetry will be conducted by Blue Water Engineers, under sub contract to Anchor Environmental, who is King County's design engineer for this cleanup project. Blue Water provides the vessel, equipment and performs the survey lines on the river and processes the data. Coordination and schedule will be managed by Anchor.

### **3.2 Dredge Material Monitoring**

Dredge material monitoring is designed to accomplish Objective 3, which is to identify dredge material that is above the PCB dangerous waste value of 50-ppm so this material can be sent to a TSCA-approved landfill. Both disposal facilities (NCD and landfill) must pre-approve sediment for disposal at their facility and they each require specific testing methods, which are different.

The Rabanco landfill managers have pre-approved all material for disposal based on the bulk sediment chemistry data (including the TCLP test for lead) collected at the cleanup site. However, because one of the 80 samples collected during the site investigation exceeded the 50-ppm TSCA waste level, King County is proposing to perform a limited amount of additional PCB testing of sediments from this area to minimize the chance that sediments shipped to the landfill have PCB values above hazardous waste level. Specifically, 2-3 individual samples would be taken from the barge after dredging of the one location in Cleanup Area B that contains the highest PCB values. Alternately samples of barge sediment may be taken when containers are filled. Chemical analysis will be completed within 24 hours. If any sediment sample has PCB concentrations in excess of 45-ppm, then the disposal contractor will be notified and the dredge material from that barge will be directed to a landfill approved to take TSCA waste.

### **3.3 Capping Material Monitoring**

Cap material monitoring is designed to accomplish Objective 4, which is to insure capping material is chemically clean prior to placement. Monitoring will focus on capping sand because the other capping materials (habitat mix and armor rock) are unlikely to have any elevated chemical values.

Sand that will be used, as the base cap material will be tested prior to placement, to ensure that the sand is chemically clean. The sand capping material will not be obtained from maintenance dredging in the Duwamish River, but will likely be purchased from a local quarry. Confirmatory testing will be performed either prior to delivery or on the first load of sand while it is on the barge. KCEL staff will collect and analyze one composite sample to represent sediment quality of the entire barge load of sand. If capping sand is purchased from more than one supplier, one composite sample will be collected and analyzed prior to acceptance and placement of the material from each supplier. If the sandy gravel habitat-mix is purchased from the same quarry then results from the base material testing will be used for suitability. The habitat mix may be difficult to accurately analyze due to its matrix makeup. Larger rock used for armoring the cap would not be chemically tested.

### **3.4 Before and After Chemistry Beyond Boundary**

A special sampling strategy has been developed to address Objective 5, which is to document whether chemical levels beyond the site boundary will increase due to

sediment moving off site during dredging. Regulatory agencies have requested that definitive information be provided to answer this question. Various options were discussed because there is a need to collect accurate data, which often requires replicate samples, be analyzed per station to provide statistical parameters. Also, there is a desire to collect information over a large area, which can result in high analytical costs if many stations must be sampled with replicate analysis.

It was agreed that for the before/after comparison it would be appropriate to use the large composite approach (10-15 grab samples/station) to quantify the chemical concentrations at each of the 12 stations. From an operational standpoint, there are advantages to using a total of 10 individual grabs for the large composite (instead of 15 individual grabs) because sub-samples from 10 individual grabs provides a more manageable volume of sediment to homogenize in the large stainless steel mixing bowls. Also, collecting 10 grabs from one station reduces the chance that the grab sampler will land in a previously sampled hole on the bottom. This is especially important since 10 additional grabs must be taken from the same station again after the cleanup action and some stations require replicates which results in a total of 20 grabs from one station.

To demonstrate the degree of variability in the large composite samples that will consist of 10 individual grabs, a single replicate sample will be taken at two of the 12 stations. (Stations 4C and 8C). These two stations will be representative of maximum sediment concentrations anticipated in the 12 stations sampled and hopefully focus on the two different COC (PCB's and phthalates). Station 4C could be influenced more by PCB's and Station 8C more by phthalates.

To document conditions before cleanup, a total of 14 chemical analysis will be performed (one individual sample from 12 stations plus replicates from 2 stations). To document conditions after cleanup, another 14 chemical analysis will be performed (one individual sample from 12 stations plus replicates from 2 stations). All 28 of these before/after sediment samples will be analyzed for the standard list of SMS chemicals to provide a complete data set. All data will be evaluated by comparing the before and after values at each station to identify differences that indicate sediments moved off site.

Various options for placing the 12 before/after stations were discussed with regulatory agencies and the locations that were finally approve are shown in Figure 1. EPA requested that before/after monitoring stations be positioned within 50 feet of the dredging and capping boundary in an effort to maximize the potential for detecting an increase. Also, it was requested that a brief statement be included in the SAP to document the reasons for selecting the various station locations.

Station 1C was positioned 50 feet upstream from the upstream boundary of Area A and about 75 feet inshore of Area B to monitor the small triangular area of undisturbed sediment that occurs between the offshore side of the pier and the cleanup area boundaries.

Station 2C was positioned 50 feet inshore of the inshore boundary of Area B and about 150 upstream of upstream boundary of Area A to monitor more of the small triangular area of undisturbed sediment that occurs between the offshore side of the pier and the cleanup area boundaries.

Station 3C was positioned 150 feet upstream of Area B and along the nearshore side of the channel to monitor for maximum potential distance in the upstream direction since this area of the channel was a depositional area with a shoal.

Station 4C was positioned 50 feet upstream of Area B and along the nearshore side of the channel to monitor for maximum potential concentration in the upstream direction since this area of the channel was a depositional area with a shoal. This station was selected as a one of the replicates because it has a higher chance of showing any increased values in the after samples due to its short distance upstream.

Station 5C was positioned 50 feet farther into the channel then the offshore boundary of Area B and opposite the upstream boundary of Area B to monitor the channel area adjacent to the upstream end of Area B.

Station 6C was positioned 50 feet farther into the channel then the offshore boundary of Area B and 220 feet down stream from the upstream boundary of Area B to monitor the potential highest concentrations in the channel adjacent to the PCB hotspot located in the middle of Area B. The offshore boundary of Area B is about 480 feet long and is 50 feet inside of the channel.

Station 7C was positioned 50 feet farther into the channel then Station 6C (100 feet from Area B boundary) to monitor for maximum cross channel distance in the area closest to the PCB hotspot in Area B.

Station 8C was positioned 50 feet into the channel from the offshore boundary of Area A and about 200 feet downstream from the upstream boundary of Area A to monitor for maximum potential concentration in the channel area near the highest phthalate values previously found in Area A. Along with Station 4C this station will be used as a replicate because of its higher chance of showing any increased values in the after samples. Also, this station is located about in the center of the entire 1230 feet length of both capping Areas A (750 feet long) and B (480 feet long) together.

Station 9C is located 50 feet into the channel from the offshore boundary of Area A and about 450 feet from the upstream boundary of Area A to monitor for maximum potential effect in the channel near the part of Area A that contains high phthalate values. Also, this station is near the center of the 750 foot long offshore boundary of capping Area A.

Station 10C was positioned 50 feet into the channel from the offshore boundary of Area A and 50 feet downstream of the downstream boundary of Area A to monitor the potential maximum concentration in the channel near the small chemical hot spot located near the downstream corner of capping Area A.

Station 11C was positioned 50 feet downstream of the downstream boundary of Area A to monitor potential maximum concentration in the downstream direction and inshore of the channel.

Station 12C was positioned 150 feet downstream of the downstream boundary of Area B to monitor for the potential maximum distance that Area A material could be detected downstream.

### **3.5 Additional Sediment Survey Beyond Boundary**

A limited-survey of bottom sediment beyond the cleanup boundary was added to accomplish the final Objective 6, which is to document whether elevated chemical levels (especially PCBs) in areas beyond the site boundary could be a source of contamination to the cap surface. A secondary need expressed by regulatory agencies was to adequately characterize areas immediately adjacent to the cleanup site.

To provide additional information about sediment conditions beyond the site boundary, King County will perform a limited-survey of 8 more stations in addition to the 12 stations that were sampled in the before/after comparison. The following areas were previously identified as potentially requiring further characterization: 1) downstream of Cleanup Area A, 2) navigation channel adjacent to Cleanup Area A, 3) navigation channel downstream of Cleanup Area A, and 4) inshore of Cleanup Area B. Prior to conducting the limited-survey of 8 stations, King County will provide EPA and Ecology a copy of the proposed station locations for review and comment. Selection of final sampling locations will be determined based on comments received. The schedule for collecting the 8 limited-survey samples would be either at the same time as the 12 after-cleanup stations are sampled or delayed to allow the data from the 12 after-cleanup stations (10 grabs per station) to be reviewed. King County's opinion is that it would be advantageous to wait until the data from the 12 before/after samples have been reviewed before selecting the 8 additional stations.

When the 8 limited-survey stations are added to the 12 stations used for before/after comparison, there will be a total data set of 20 stations sampled after the cleanup that should provide considerable information about sediment conditions beyond the site boundary. The 8 limited-survey samples will be analyzed for the standard list of SMS chemicals to provide a complete data set. The sampling method used during the limited-survey will be the large (10 grab) composite of many grabs from one station as was used for the before/after comparison.

### **3.6 Long-Term Monitoring of Chemical Concentrations on Cap Surface**

Long-term monitoring of the cap surface is designed to accomplish Objective 7, which is to document potential future contamination due to continuing point sources. The surface of the cap can become recontaminated either from continuing CSO/SD discharges at the

site or from contaminated sediment on adjacent property washing onto the cap surface. The primary discharge source is the Diagonal CSO/SD that has an annual discharge of about 1,230 million gallons of storm water and less than 65 million gallons of CSO. The Duwamish CSO has a low potential to overflow and has not overflowed in the past 11 years; however, the discharge is still considered to be at a frequency of up to one event per year. A separate source control plan is being implemented for the Duwamish/Diagonal drainage basin and includes a sampling program that involves sampling various point sources and non-point sources within the drainage basin.

Accumulation of surface sediment contamination on the Du/Di sediment cap will be evaluated by collecting and analyzing grab samples from five stations in Cleanup Area A and three stations in Cleanup Area B. The location of sampling stations for long-term monitoring chemical concentrations on the cap surface were discussed with regulatory agencies and the locations that were finally approved are shown in Figure 1. As requested a brief statement of the reason for selecting these stations is provided below.”

Station 1A was positioned 100 feet offshore from Diagonal CSO/SD outfall to monitor potential recontamination from the CSO/SD outfall, which discharges mostly separated storm water.

Station 2A was positioned 100 feet downstream of the upstream boundary of Area A to monitor potential recontamination due to resuspension of contaminated sediments present in the small triangular area between the offshore side of the pier and the cleanup boundary. Station 2A is about 175 feet upstream from the Diagonal CSO/SD outfall so it may have a potential to reflect some influence from the outfall, but to a lesser extent.

Station 3A was positioned 50 feet inshore from the offshore boundary of Area A to monitor for potential recontamination of the cap from resuspension of contaminated sediments in the channel. Station 3A is about 220 feet offshore from the Diagonal CSO/SD outfall and near the high phthalate concentrations observed prior to dredging so this station could also reflect input from the outfall.

Station 4A was positioned about 375 feet downstream and offshore from the Diagonal CSO/SD to monitor recontamination from the outfall because this is the only part of Area A that has sand at the surface instead of the gravel habitat mix. The sand cap material is at the surface in a rectangle area shown in the downstream corner of Area A and this sand cap material will likely be easier to detect chemical differences than the habitat mix.

Station 5A was positioned 50 feet inside of the offshore boundary of Area A and 50 feet upstream of the downstream boundary of Area A to monitor potential recontamination from the channel area when elevated chemicals had been observed previously. This area contains sand cap material at the surface and should reflect changes faster than habitat mix material.

Station 1B is located 50 feet inside of the offshore boundary of Area B and about 200 feet downstream from the upstream boundary of Area B to monitor potential recontamination from resuspended sediments in the channel because this is an area of past shoaling.

Station 2B is located 50 feet inside of the nearshore boundary of Area B and 150 feet upstream from the downstream boundary of Area B to monitor for potential recontamination of the cap from resuspension of contaminated sediments in the rectangular area located between the offshore side of the pier and the cap boundary. This station is opposite Station 2C, which is located on the rectangular area.

Station 3B is located 50 feet inside of the nearshore boundary of Area B and 50 feet upstream from the downstream boundary of Area B to monitor for potential recontamination of the cap from resuspension of contaminated sediments in the triangular area located between the offshore side of the pier and the cap boundary. This station is opposite Station 1C, which is located on the rectangular area.

KCEL staff will collect these samples using a small vessel outfitted with a crane and van Veen grab sampler. All samples will be collected, handled, and processed in accordance with previous Du/Di Sampling and Analysis Plans/Addenda (EBDRP 1994, 1995). At each station a minimum of three grab samples will be composited and homogenized for laboratory analysis. A stainless steel spoon will be used to collect the top 10 centimeters of sediment from three replicate grab samples per station. Each 0-10-cm composite sample will be analyzed for SMS chemicals and associated parameters such as total organic carbon, total solids, and particle size distribution. When habitat material is sampled there may be a need to use different sampling equipment and to sieve the sample to remove large gravel.

The cap will be sampled within 3 months after cap placement to document baseline surface sediment conditions. Surface sediment stations will be sampled each year for the first 5 years following cap placement. However, the frequency of sampling events to be carried out during the next 5 years will be determined based on the rate of recontamination during the first 5 years. If recontamination is observed on the surface of the cap procedures will be implemented to evaluate whether the contamination is a result of off-site sources or upward migration of contaminants from beneath the cap. Due to most of the cap being covered with habitat mix and rip-rap coring through the cap to monitor sediment would be difficult and need to be limited to a very small area of the cap. If recontamination appears to be stabilized, then sampling may be reduced to alternating years or longer between sampling events. A project monitoring review meeting with EPA and Ecology will be held after 5 years to decide future monitoring frequency. Chemistry data for each station will be reported in dry weight values to show trends in chemical levels each year and will also be normalized to organic carbon where appropriate for comparison to SMS criteria values.



### **3.7 Long-Term Monitoring of Cap Thickness for Stability**

Monitoring for cap thickness over time is designed to accomplish Objective 8, which is to document cap stability for isolating the underlying contaminated sediments over time. A significant part of the engineering and design of Cleanup Areas A and B was cap stability, which is needed to prevent the cap from being washed away. Areas near the pier that are subject to strong prop wash from tug boats, were armored with large rock to protect the underlying base capping sand from erosion. From an engineering standpoint, the areas away from the pier that are covered with smaller size armoring material may be the most significant areas to monitor cap stability. However, regulatory agencies expressed interest in obtaining information on cap stability in all areas of the cap.

Stability of the cap will be determined by monitoring for sediment erosion in various areas of the cap. There are three potential methods to monitor for erosion of the cap as follows: 1) install measuring stakes in the surface of the cap; 2) conduct detailed bottom surveys to define the cap surface, 3) and visual inspect cap surface by underwater camera or diver survey. The first approach is most accurate, but it is not recommended due to technical and policy issues. The second approach is recommended because it is readily available, but it measures changes over a larger area. The third approach could be used for spot checks, but is difficult to quantify and requires good under water visibility.

Installing many measuring stakes that extend above and below cap provides a reproducible grid that allows small changes in the cap to be measured accurately. However, concern has been raised that the fixed stakes would become an obstruction for Tribal gill net fishing activities conducted in this area of the river. One possible solution is to design a flexible stake (similar to a bicycle flagpole) that would not snag gill nets and would be approved by the tribe. One limitation of stakes is that they can be broken off due to boat or barge anchoring and this situation has occurred at two sediment caps King County has been monitoring along the Seattle waterfront in Elliott Bay. Another potential difficulty to using stakes could be installing the stakes in areas of the cap that are armored with rock. There are currently too many unknowns about whether stakes could be successfully used at this site to propose stakes as the primary measuring approach; however, some secondary roll could arise if the use of a few stakes were approved by the tribe. (stakes used to calibrate other measurement methods).

Detailed bathymetry surveys will be conducted many times during the dredging and capping and can be used to look for changes in the cap surface over time. During these detailed bottom surveys many transect lines are run perpendicular to shore at 25 foot spacing between transect lines plus some additional transect lines are run parallel to shore. Because the boat path varies a little each year, it is not accurate to simply compare each individual transect line against the previous years transect line. Instead, a computer program uses all the data to mathematically calculate surface elevations for the entire cap. Each year, the data from the new survey is used to calculate new surface elevations over the entire cap. The computer program can also calculate the apparent differences between the two years and spatially display any significant erosion or deposition. Overall accuracy of the bathymetry survey depends on obtaining precise river surface level

data (tide height) that must be used to correct and normalize the bathymetry data to mean lower low water (MLLW) values. If bottom depth data showed the cap were becoming too thin, regulatory agencies would be notified and the cause investigated (erosion or physical damage) and a remedy selected for providing repairs to the cap.

Visual inspection by underwater camera or diver survey could be used to show whether the armor rock is exposed due to loss of the one-foot thick layer of habitat mix. However, it is not possible to quantify these visual observations of change. Also, it turns out that the loss of habitat mix from armor rock is not really an indication of cap stability for isolation protection, because the base capping layer of sand that provides the isolation layer is actually under the large armor rock. One requirement of the HPA is to monitor whether the habitat mix erodes away from the armor rock so visual inspection will be performed first using an underwater video camera lowered to the bottom and moved along transect lines. If the remote camera did not provide adequate information then a diver would videotape transect lines in the area with armor rock.

### **3.8 Review and Revisions to Long-Term Monitoring**

After the long-term monitoring program is underway, revisions may be needed to respond to specific results obtained. For example, if chemical levels of phthalates in surface sediments exceed SQS or the CSL value, then the monitoring program will be expanded to include bioassay testing of these sediments. The bioassay testing could show that even though the SQS/CSL value is exceeded there is no biological toxicity produced, which is the situation previously observed. Another opportunity to discuss potential changes in the monitoring plan is during the 5-year review meeting for the monitoring plan.

It is important to remember that point source monitoring activities for the Diagonal CSO/SD basin, are not currently included in this construction and post-construction monitoring plan because point source monitoring programs are conducted by different parts of King County and the City of Seattle.

## **4.0 Project Team and Responsibilities**

Project team members and their responsibilities are summarized in Table 2. All team members are staff of the King County Department of Natural Resources and Parks, either within the Water and Land Resources Division or Wastewater Treatment Division.

**Table 2. Project team members and responsibilities.**

| <b>Name/Telephone</b>               | <b>Title</b>                 | <b>Affiliation</b>                      | <b>Responsibility</b>  |
|-------------------------------------|------------------------------|---|--|
| Priscilla Hackney<br>(206) 684-1791 | KC Engineer/Project Manager  | Wastewater Treatment Division           | Manager for Duwamish Diagonal Sediment Remediation Project                               |
|                                     |                              |   |  |
| Pat Romberg<br>(206) 296-8251       | Senior Water Quality Planner | Science, Monitoring and Data Management | EBDRP Program Manager<br>Sediment cleanup advisor  |
|                                     |                              |   |  |
| Colin Elliott<br>(206) 684-2343     | Quality Assurance Officer    | Environmental Laboratory                | Overall analytical and Field QA/QC   |
|                                     |                              |   |  |
| Fritz Grothkopp<br>(206) 684-2327   | Laboratory Project Manager   | Environmental Laboratory                | Coordination of sampling and analytical activities, laboratory QA/QC, and data reporting |
|                                     |                              |   |  |

## **5.0 Schedule**

Detailed bottom depth surveys will be conducted before, during and after construction.

Samples of dredge material will be collected and tested for PCB's during November 2003 if sediments are sent to Rabanco.

Samples of capping material will be collected and analyzed for SMS chemicals prior to capping, which would be near the beginning of January 2004.

Long term monitoring of cap surface would be annual for 10 years and start within 3 months after cap is placed. Sampling would occur prior to June 1, 2004 and an annual report of data would be provided to regulatory agencies.

Sampling of the sediment outside the perimeter of the cleanup areas will be done prior to dredging operations and within two months of the completion of capping operations. The post capping perimeter sediment collection event will be completed prior to the first long term cap monitoring event.

## **6.0 Sample Design**

### **6.1 Data Quality Indicators**

The following data quality indicators have been established to meet the needs of this project.

### **6.1.1 Precision, Accuracy, and Bias of Field and Laboratory Measurements**

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy, and bias for analytical chemistry may be measured by one or more of the following quality control (QC) procedures:

- Analysis of various laboratory QC samples such as method blanks, matrix spikes, certified reference materials, and laboratory duplicates (laboratory QC results will be evaluated against the control limits presented in Section 9).
- Collection and analysis of replicate field samples for laboratory and field measurement (replicate results should exhibit a relative percent difference less than 50% in order for the evaluation of the spatial and temporal chemical concentrations to be meaningful)
- Collection and analysis of total metals field blanks (results should be less than the method detection limit).

### **6.1.2 Representativeness**

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point, or an environmental condition. Samples are to be collected to minimize potential contamination and other types of degradation in the chemical and physical composition of the water. Laboratory representativeness is achieved by proper preservation and storage of samples along with appropriate subsampling and preparation for analysis. Data that is not representative as defined above should not be used.

### **6.1.3 Completeness**

Completeness is defined as the total number of samples analyzed for which acceptable and representative analytical data are generated, compared to the total number of samples to be analyzed. The goal for completeness is 100%. The samples from each event should produce greater than 90% acceptable chemical data under the QC conditions mentioned in Section 11.

### **6.1.4 Comparability**

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. Changes or updates to analytical methods and sampling techniques midway into the project must be validated and shown to be equivalent to existing methods before being implemented.

## 7.0 Sample Collection Procedures

Standard bottom sampling methods will be used to sample stations with soft sediments; however, after the cap is constructed most of the cap surface will be covered with habitat mix (sandy gravel), which may require use of different sampling equipment and procedures to obtain a sufficient amount of fine sediment to submit for chemical analysis.

### 7.1 Summary

All sediment sampling will be performed according to PSEP guidance (PSEP 1997, 1998). Marine sediment samples from stations with soft sediment will be collected using multiple casts of two 0.1 m<sup>2</sup> modified, stainless steel van Veen grab samplers deployed in tandem via hydrowire and hydraulic winch from King County's research vessel *Liberty or Chinook*. Chemistry samples will be collected from the top 10 centimeters (cm) of sediment from each successful deployment (see 7.4). Sediment samples will be stored on ice in coolers while in the field, then transported to the laboratory at the end of each sampling day. The majority of the cap surface will be covered with a layer of sandy gravel called habitat mix, which may not be readily sampled to a depth of 10-cm with the van Veen grab sampler. A different grab sampler may be needed to collect deeper samples of habitat mix. Also, only fine materials would be used for chemical analysis and requires that larger gravel and rock be removed from the sample by sieving.

### 7.2 Station Positioning

Station positioning will employ a Trimble® Differential Global Positioning System (DGPS). Prior to the sampling event, the prescribed station coordinates will be entered into the shipboard DGPS laptop computer. During the sampling event, the shipboard navigational system will utilize the differential data transmissions from regional Coast Guard base stations to automatically correct its GPS satellite data. The GPS antenna is boom-mounted above the sampler descent line to achieve a more accurate coordinate fix above the sampling point.

Upon contact of the grab sampler with the bottom, the coordinate data representing the actual sediment grab impact point will be electronically recorded in real time. Positioning information will include local time and date that a position is recorded, comments, and coordinate data in both latitude/longitude and NAD 83 State Plane formats.

Previous DGPS usage indicates that an average precision of  $\pm$  two meters can usually be expected. Sample collection is expected to take place within a three-meter radius of each station's prescribed position and samples will not be collected if the grab deployment is outside of this limit. If conditions such as a steep slope or rocky substrate preclude sample collection at a particular station, the station may be relocated after consultation with the study coordinator and if relocation will not compromise the project goals. Any station relocation will be well documented. Even though a large part of the cap surface

will be covered with sandy gravel habitat mix it is anticipated that samples of the habitat mix can be collected using an appropriate sediment grab sampler.

### **7.3 Sampler Deployment and Retrieval**

Two 0.1 m<sup>2</sup> modified, stainless steel van Veen grab samplers will be deployed in tandem at each sampling station that has soft sediments; however, in areas of the cap covered with habitat mix a different type sampler may be required to obtain sufficient penetration into the bottom. When sampling soft sediments, the van Veen grab samplers will be lowered at a controlled speed of approximately four feet per second until it is near the bottom, at which time the speed will be decreased to approximately one foot per second to minimize potential bow wake activity and subsequent bottom disturbance.

After the grabs have tripped upon reaching the bottom, they will be raised slowly to allow gentle and complete closure of the sampler jaws to avoid sample disturbance and loss. Once clear of the bottom, the ascent speed will be increased to approximately four feet per second. Care will be taken to ensure that minimal sample disturbance occurs when swinging the grabs on board. Collection of undisturbed sediment requires that the grab samplers:

- create a minimal bow wake when descending;
- form a leak-proof seal upon closure of the jaws;
- are carefully retrieved to prevent excessive sample disturbance; and
- allow easy access to the sediment within the grab.

A minimum of two successful deployments of the tandem grab samplers will be required at each station for the collection of one sediment chemistry sample.

For large composites of 10 grabs per station a minimum of 5 successful deployments of the tandem grab sampler are required at each station for the collection of one sediment chemistry sample. Sediment samples taken to monitor long-term changes in chemical levels in the cap surface will typically use 3 grab composites so a minimum of two successful deployments of the tandem grab samplers will be required at each station. However, the habitat mix on the cap surface may contain only small amounts of fine sediment that can be used for chemical analysis; therefore, it may be necessary to collect more than three sediment grabs per station to obtain enough fine grain material to serve as a representative sample.

### **7.4 Sample Acceptability Criteria**

When the grab samplers have been secured on board, the hinged top flaps will be opened and the samples examined for acceptability. Acceptability criteria will include;

- the grabs are not overfilled to the point where there is evidence of sample loss around the access doors;
- overlying water is present, indicating minimal leakage;
- overlying water is not excessively turbid, indicating minimal sample disturbance; and
- a minimum acceptable sample penetration depth of at least 11-cm has been achieved.

Samples for chemical analysis in soft sediments will be collected from the top 10-cm of sediment, so a minimum penetration depth of 11-cm will be required for these grabs. Care will be taken to extract sediment from the most undisturbed center portion of each grab without collecting sediment that has touched the sides of the grab. If repeated grabs show less than 11-cm retrieval then it will be acceptable to collect a sample of less than 10-cm but this will be noted on field sheets and flagged on final data tables. This provision is allowed to insure samples are obtained from the 12 before and after stations beyond the site boundary.

During post-construction monitoring of the cap surface, the van Veen grab sampler may have difficulty collecting 10-cm deep grab samples in areas covered with habitat mix. Consequently, a different grab sampler, such as the Petterson grab sampler, could be used to obtain deeper penetration into the gravel habitat mix. If it is determined to be unreasonably difficult to collect 10-cm deep samples in areas of the cap covered with habitat mix, then an alternate depth of penetration less than 10-cm would be proposed as the acceptable sample depth and discussed with regulatory agencies. Another problem with sampling habitat mix is that sediment samples for chemical analysis are routinely sieved to remove larger gravel material, which may result in only a small amount of fine sediment material retained for analysis. If only small amounts of fines are present in each grab sample of habitat mix, it may be necessary to collect many grabs of habitat mix or to use the entire grab contents of each grab to obtain sufficient fine material to submit for chemical analysis.

### **7.5 Sample Processing - Sediment Chemistry Analysis**

Overlying water within the grab will be carefully siphoned off of the sediment surface for all acceptable samples of soft sediment. The top 10-cm of sediment will be collected with a stainless steel spoon and placed in a stainless steel bowl for homogenization.

To better control the volume of soft sediment that must be homogenized for large composites of 10 grabs it will be necessary to take a smaller sub-sample from each grab by using a stainless steel core tube to collect these sub-samples instead of a stainless steel spoon. King County routinely uses stainless steel core tubes (2-inch diameter) to collect hand driven core samples of soft intertidal sediment. This approach can be used to sub-sample the 10 sediment grabs that will be composited, and will allow a precise volume of soft sediment to be collected, which should result in more equitable representation within each composite sample. The sub-sample from each soft sediment grab to be composited will consist of a minimum of two hand core samples so that the 10 individual grabs will yield 20 core samples to be homogenized. Also, the hand cores will be taken from the deepest part of the soft sediment in the grab sampler and each hand core will be taken from opposite sides of the grab sampler when possible.

Samples of gravel habitat mix taken from the cap surface will be sieved to remove larger gravel and only the fine sediment material will be used for chemical analysis. Numerous grabs may be required to obtain enough fine material to submit for chemical analysis and it may be necessary to use the entire sample instead of taking sub-samples.

After thorough homogenization, the sediment will be transferred to the other laboratory containers. Headspace will be left in all lab containers to allow for further mixing within the laboratory and for expansion in those containers that are stored frozen. All samples will be stored in insulated, ice-filled coolers while in the field.

Sample containers, storage conditions, and holding times are summarized in Table 3.

**Table 3 - Sample Containers, Storage Conditions, and Analytical Hold Times**

| <b>Analyte</b>                       | <b>Container</b>               | <b>Preferred Storage Conditions</b> | <b>Hold Time</b>                        | <b>Acceptable Storage Conditions</b> | <b>Hold Time</b>                         |
|--------------------------------------|--------------------------------|-------------------------------------|---|--------------------------------------|--|
| BNAs                                 | 16 oz. glass                   | freeze at -18°C                     | 1 year to extract<br>40 days to analyze | refrigerate at 4°C                   | 14 days to extract<br>40 days to analyze |
| Chl. Pest./PCBs<br>(collect w/ BNAs) | 16 oz. glass                   | freeze at -18°C                     | 1 year to extract<br>40 days to analyze | refrigerate at 4°C                   | 14 days to extract<br>40 days to analyze |
| Mercury                              | 250 ml HDPE                    | freeze at -18°C                     | 28 days to analyze                      | N/A                                  | N/A                                      |
| Other Metals                         | 250 ml HDPE                    | freeze at -18°C                     | 2 years to analyze                      | refrigerate at 4°C                   | 6 months to analyze                      |
| Particle Size<br>Distribution        | 1 gal. plastic<br>zip-type bag | refrigerate at 4°C                  | 6 months to analyze                     | N/A                                  | N/A                                      |
| Total Organic<br>Carbon              | 4 oz. glass                    | freeze at -18°C                     | 6 months to analyze                     | refrigerate at 4°C                   | 14 days to analyze                       |
| Total Solids<br>(collect w/ TOC)     | 4 oz. glass                    | freeze at -18°C                     | 6 months to analyze                     | refrigerate at 4°C                   | 14 days to analyze                       |

## 7.6 Sampling Equipment Decontamination

The grab samplers will be decontaminated between sampling stations by scrubbing with a brush and using phosphate-free soap, followed by a thorough ambient seawater rinsing. A separate stainless steel bowl and spoon will be dedicated to each sampling station, precluding the need for decontamination of this equipment.

## 7.7 Sample Storage and Delivery

All sample containers will be stored in an insulated cooler containing ice immediately after collection to maintain the samples at a temperature of approximately 4° Celsius until delivery to the laboratory. Chemistry sample containers from each station will be grouped and placed in plastic bags to facilitate sample receipt and login. At the end of each sampling day, all chemistry samples will be transported back to the King County Environmental Laboratory.

## 7.8 Chain of Custody

Chain of custody (COC) will commence at the time that each sample is collected. While in the field, all samples will be under direct possession and control of King County field staff. For chain of custody purposes, the research vessel will be considered a “controlled area.” Each day, all sample information will be recorded on a COC form (Figure 2).



This form will be completed in the field and will accompany all samples during transport and delivery to the laboratory each day.

## Figure 2. King County Environmental Laboratory Chain of Custody Form

### LABORATORY WORK ORDER

#### Chain of Custody

Project Name: Duwamish/Diagonal Sediment Remediation

Project Number: 423056, subproject 120, phase 4

Laboratory Project Manager: Fritz Grothkopp/John Blaine

Telephone Number: 684 2327/2323

King County Department of Natural Resources

Water and Land Resources Division

Environmental Laboratory

322 West Ewing Street

Seattle, Washington 98119-1507

| Sample Number                                     | Client Locator | Collect Date | Collect Time | Analyses                   |       |                  |                 |           |  |   |  |  |  |  |  | Number of Containers | Comments |
|---|----------------|--------------|--------------|----------------------------|-------|------------------|-----------------|-----------|--|---|--|--|--|--|--|----------------------|----------|
|   |                |              |              | TOC/TOT5                   | PSD * | Metals + HG-CVAA | BNAL/PESTL/PCBL | VOA-GC/MS |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| L -   |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| Additional Comments:                              |                |              |              | Total Number of Containers |       |                  |                 |           |  |   |  |  |  |  |  | Sampled By:          |          |
| * Sub-contracted lab parameters.                  |                |              |              |                            |       |                  |                 |           |  |   |  |  |  |  |  |                      |          |
| Relinquished By:                                  |                |              |              |                            |       |                  |                 |           |  | Received By:                                      |  |  |  |  |  |                      |          |
| Signature   |                |              |              |                            |       |                  |                 |           |  | Signature   |  |  |  |  |  |                      |          |
| Date  |                |              |              |                            |       |                  |                 |           |  | Date  |  |  |  |  |  |                      |          |
| Printed Name                                      |                |              |              |                            |       |                  |                 |           |  | Printed Name                                      |  |  |  |  |  |                      |          |
| Time  |                |              |              |                            |       |                  |                 |           |  | Time  |  |  |  |  |  |                      |          |
| Organization King County Environmental Laboratory |                |              |              |                            |       |                  |                 |           |  | Organization King County Environmental Laboratory |  |  |  |  |  |                      |          |

Upon arrival at the King County Environmental Laboratory, the sample delivery person will relinquish all samples to the sample login person. The date and time of sample delivery will be recorded and both parties will then sign off in the appropriate sections on the COC form at this time. Once completed, the original will be archived in the project file.

Samples delivered after regular business hours will be stored in a locked chain of custody refrigerator until the next day. Samples delivered to a subcontracted laboratory will be accompanied by a properly completed King County Environmental Laboratory COC form and custody seals will be placed on the cooler if samples are delivered by an outside courier. Subcontracted laboratories will be expected to provide a copy of the completed COC form as part of their analytical data package.

### 7.9 Sample Disposal

All sediment chemistry sample material will be disposed according to established King County Environmental Laboratory procedures after analysis has been completed.

## 8.0 Sample Documentation

Sampling information and sample metadata will be documented using the methods noted below.

- Field sheets generated by King County's Laboratory Information Management System (LIMS) that will include information such as:
  1. sample ID number
  2. station name
  3. station bottom depth
  4. sediment depth (i.e., sampler penetration depth) for each successful deployment
  5. sediment sampling range (depth from surface collected for analysis)
  6. physical sediment characteristics
  7. date and time of sample collection
  8. condition and height of tide
  9. name of recorder
- LIMS-generated container labels will identify each container with a unique sample number, station and site names, collect date, analyses required, and preservation method.
- The *Liberty's* logbook will contain records of all shipboard activities, destinations, arrival and departure times, general weather and positioning information, the names of shipboard personnel.
- The *Liberty's* cruise plan will list the prescribed stations to be sampled, along with their respective coordinates and other associated locating information.
- Electronic DGPS coordinate data will be electronically logged for each grab sample using both latitude/longitude and NAD 83 State Plane formats.
- COC documentation will consist of the Lab's standard COC form, which is used to track release and receipt of each sample from collection to arrival at the lab.

A sample of a typical field sheet used by the King County Environmental Laboratory is included as Figure 3.

### Figure 3. King County Environmental Laboratory Field Sheet

Login Number: T\_DUDI\_PRMSD

Page: 1

#### DUDI SEDIMENT REMEDIATION PROJECT

Project Number: 423056-120

Personnel: \_\_\_\_\_

|                  |                |                |                |
|------------------|----------------|----------------|----------------|
| Sample Number    | T_DUDI_PRMSD-1 | T_DUDI_PRMSD-2 | T_DUDI_PRMSD-3 |
| Locator          | DUD201         | DUD202         | DUD203         |
| Short Loc. Desc. |                |                |                |
| Locator Desc.    |                |                |                |
| Site             | DUWAMISH RIVER | DUWAMISH RIVER | DUWAMISH RIVER |
| Start Time       |                |                |                |
| End Time         |                |                |                |
| Sample Depth     |                |                |                |
| Collect Date     |                |                |                |
| Comments         |                |                |                |

  

|                     |                              |                              |                              |
|---------------------|------------------------------|------------------------------|------------------------------|
| Dept., Matrix, Prod | 0   SALTWRSED   BNALLFULL    | 0   SALTWRSED   BNALLFULL    | 0   SALTWRSED   BNALLFULL    |
|                     | 0   SALTWRSED   CLIENT LOC   | 0   SALTWRSED   CLIENT LOC   | 0   SALTWRSED   CLIENT LOC   |
|                     | 0   SALTWRSED   PCBLL        | 0   SALTWRSED   PCBLL        | 0   SALTWRSED   PCBLL        |
|                     | 0   SALTWRSED   PESTLL       | 0   SALTWRSED   PESTLL       | 0   SALTWRSED   PESTLL       |
|                     | 0   SALTWRSED   PSD          | 0   SALTWRSED   PSD          | 0   SALTWRSED   PSD          |
|                     | 0   SALTWRSED   SAMP DEPTH   | 0   SALTWRSED   SAMP DEPTH   | 0   SALTWRSED   SAMP DEPTH   |
|                     | 0   SALTWRSED   SAMP DESCRIP | 0   SALTWRSED   SAMP DESCRIP | 0   SALTWRSED   SAMP DESCRIP |
|                     | 0   SALTWRSED   SAMP METH    | 0   SALTWRSED   SAMP METH    | 0   SALTWRSED   SAMP METH    |
|                     | 0   SALTWRSED   SAMP TEMP    | 0   SALTWRSED   SAMP TEMP    | 0   SALTWRSED   SAMP TEMP    |
|                     | 0   SALTWRSED   SAMPCOORDX1  | 0   SALTWRSED   SAMPCOORDX1  | 0   SALTWRSED   SAMPCOORDX1  |
|                     | 0   SALTWRSED   SAMPCOORDX10 | 0   SALTWRSED   SAMPCOORDX10 | 0   SALTWRSED   SAMPCOORDX10 |
|                     | 0   SALTWRSED   SAMPCOORDX2  | 0   SALTWRSED   SAMPCOORDX2  | 0   SALTWRSED   SAMPCOORDX2  |
|                     | 0   SALTWRSED   SAMPCOORDX3  | 0   SALTWRSED   SAMPCOORDX3  | 0   SALTWRSED   SAMPCOORDX3  |
|                     | 0   SALTWRSED   SAMPCOORDX4  | 0   SALTWRSED   SAMPCOORDX4  | 0   SALTWRSED   SAMPCOORDX4  |
|                     | 0   SALTWRSED   SAMPCOORDX5  | 0   SALTWRSED   SAMPCOORDX5  | 0   SALTWRSED   SAMPCOORDX5  |
|                     | 0   SALTWRSED   SAMPCOORDX6  | 0   SALTWRSED   SAMPCOORDX6  | 0   SALTWRSED   SAMPCOORDX6  |
|                     | 0   SALTWRSED   SAMPCOORDX7  | 0   SALTWRSED   SAMPCOORDX7  | 0   SALTWRSED   SAMPCOORDX7  |
|                     | 0   SALTWRSED   SAMPCOORDX8  | 0   SALTWRSED   SAMPCOORDX8  | 0   SALTWRSED   SAMPCOORDX8  |
|                     | 0   SALTWRSED   SAMPCOORDX9  | 0   SALTWRSED   SAMPCOORDX9  | 0   SALTWRSED   SAMPCOORDX9  |
|                     | 0   SALTWRSED   SAMPCOORDY1  | 0   SALTWRSED   SAMPCOORDY1  | 0   SALTWRSED   SAMPCOORDY1  |
|                     | 0   SALTWRSED   SAMPCOORDY10 | 0   SALTWRSED   SAMPCOORDY10 | 0   SALTWRSED   SAMPCOORDY10 |
|                     | 0   SALTWRSED   SAMPCOORDY2  | 0   SALTWRSED   SAMPCOORDY2  | 0   SALTWRSED   SAMPCOORDY2  |
|                     | 0   SALTWRSED   SAMPCOORDY3  | 0   SALTWRSED   SAMPCOORDY3  | 0   SALTWRSED   SAMPCOORDY3  |
|                     | 0   SALTWRSED   SAMPCOORDY4  | 0   SALTWRSED   SAMPCOORDY4  | 0   SALTWRSED   SAMPCOORDY4  |

continue ...

#### CHAIN OF CUSTODY

|                              |       |                          |       |
|------------------------------|-------|--------------------------|-------|
| RELINQUISHED BY<br>Signature | Date  | RECEIVED BY<br>Signature | Date  |
| Printed Name                 | Time  | Printed Name             | Time  |
| Sample Number(s)             | (All) | Sample Number(s)         | (All) |

## 9.0 Field Measurements and Observations

The following field measurements and observations will be recorded for each sediment sample:

- sample (bottom) depth - measured as keel depth by vessel's fathometer;
- sediment depth (grab penetration depth) - measured by ruler inside the grab;
- sediment sampling range (0 to 10-cm for each chemistry sample);
- sediment type (a mnemonic code indicating color, gross grain size, odor, and debris);
- tide condition and height; and
- collect date, time, and sampling personnel.

## 10.0 Analytical Parameters and Methods

Analytical parameters for chemical analysis are presented in the following sections. Parameters have been selected based on guidance for conducting baseline sediment characterizations (Ecology 2003) and will allow comparison with published sediment quality criteria (Ecology 1995; ACOE 2000). All analyses will follow PSEP guidance (PSEP 1986, 1987, 1997b, and 1997c).

The terms MDL and RDL, used in the following sections, refer to *method detection limit* and *reporting detection limit*, respectively. The MDL is defined as *the minimum concentration of a chemical constituent that can be detected*, while the RDL is defined as *the minimum concentration of a chemical constituent that can be reliably quantified*. The MDL and RDL are based on routine method concentration factors, assuming 50% total solids by weight. Also, the RDL could be considered equivalent to a Practical Quantitation Limit (PQL).

### 10.1 Conventional Analytical Methods and Detection Limits

Conventional sediment parameters analyzed at the King County Environmental Laboratory include total organic carbon (TOC), and total solids. Analysis of particle size distribution (PSD) will be subcontracted to another Ecology-accredited analytical laboratory. The analytical methods and detection limits for conventional parameters analyzed at the King County Environmental Laboratory are summarized in Table 4.

**Table 4 - Conventional Methods and Detection Limits  
(King County Environmental Laboratory)**

| Parameter            | Method          | MDL   | RDL  | Units           |
|----------------------|-----------------|-------|------|-----------------|
| Total Organic Carbon | EPA 9060-PSEP96 | 1000  | 2000 | mg/Kg dry wt.   |
| Total Solids         | SM 2540-G       | 0.005 | 0.01 | percent wet wt. |

The analytical methods and detection limits for the subcontracted conventional chemistry parameters are summarized in Table 5.

**Table 5 - Conventional Methods and Detection Limits  
(Contract Laboratory)**

| Parameter                  | Method    | MDL | Units           |
|----------------------------|-----------|-----|-----------------|
| Particle Size Distribution | ASTM D422 | 0.1 | percent wet wt. |
|                            |           |     |                 |

## 10.2 Metals Analytical Methods and Detection Limits

All metals analyses will be performed at the King County Environmental Laboratory. The analytical methods and detection limits for the target metals are summarized in Table 6. Mercury will be analyzed by cold vapor atomic absorption spectroscopy (CVAA) and other metals will be analyzed by inductively coupled plasma optical emission spectroscopy (ICP-OES) with a strong acid digestion.

**Table 6 - Trace Metals Target Analytes, Methods,  
and Detection Limits (mg/Kg dry weight)**

| Analyte   | Method        | MDL  | RDL |
|-----------|---------------|------|-----|
| Aluminum  | EPA 3050/6010 | 10   | 50  |
| Antimony  | EPA 3050/6010 | 3    | 15  |
| Arsenic   | EPA 3050/6010 | 5    | 25  |
| Beryllium | EPA 3050/6010 | 0.1  | 0.5 |
| Cadmium   | EPA 3050/6010 | 0.3  | 1.5 |
| Chromium  | EPA 3050/6010 | 0.5  | 2.5 |
| Copper    | EPA 3050/6010 | 0.4  | 2   |
| Iron      | EPA 3050/6010 | 5    | 25  |
| Lead      | EPA 3050/6010 | 3    | 15  |
| Manganese | EPA 3050/6010 | 0.2  | 1   |
| Mercury   | EPA 7471      | 0.04 | 0.4 |
| Nickel    | EPA 3050/6010 | 2    | 10  |
| Selenium  | EPA 3050/6010 | 5    | 25  |
| Silver    | EPA 3050/6010 | 0.4  | 2   |
| Thallium  | EPA 3050/6010 | 20   | 100 |
| Zinc      | EPA 3050/6010 | 0.5  | 2.5 |

## 10.3 Organics Analytical Methods and Detection Limits

Organic parameters will include base/neutral/acid extractable semivolatiles (BNAs), chlorinated pesticides, and polychlorinated biphenyls (PCBs). The King County Environmental Laboratory will analyze all organic parameters.

The analytical methods and nominal detection limits for the target organic compounds are summarized in the following tables. Please note that the MDL and RDL values in this section are presented on a dry weight basis (50% total solids). Results for certain non-

ionizing organic compounds are normalized to organic carbon for comparison to sediment quality chemical criteria. The ability of the laboratory to attain detection limits which meet organic carbon-normalized chemical criteria will depend upon the TOC content of each sample. It has been determined for this project that the detection limits in Tables 7 and 8 will meet Wash. State DOE Sediment Quality Standard concentration values based on a review of the historical total solids and total organic carbon values for Duwamish/Diagonal sediments. A comparison table is attached to this document as an appendix.

The detection limits for the target BNA compounds are summarized in Table 7. BNA analysis is performed according to EPA methods 3550/8270 (SW 846), which employs solvent extraction with sonication and analysis by gas chromatography/mass spectroscopy (GC/MS).

**Table 7 - BNA Target Analytes and Detection Limits (µg/Kg dry weight)**

| Analyte                     | MDL  | RDL  | Analyte                      | MDL | RDL |
|-----------------------------|------|------|------------------------------|-----|-----|
| 1,2,4-Trichlorobenzene      | 0.52 | 1.0  | Benzyl Butyl Phthalate       | 12  | 24  |
| 1,2-Dichlorobenzene         | 0.52 | 1.0  | Bis(2-Chloroethoxy) Methane  | 34  | 68  |
| 1,2-Diphenylhydrazine       | 20   | 40   | Bis(2-Chloroethyl) Ether     | 29  | 58  |
| 1,3-Dichlorobenzene         | 0.52 | 1.0  | Bis(2-Chloroisopropyl) Ether | 29  | 58  |
| 1,4-Dichlorobenzene         | 0.26 | 0.52 | Bis(2-Ethylhexyl) Phthalate  | 13  | 26  |
| 2,4,5-Trichlorophenol       | 24   | 48   | Carbazole                    | 14  | 28  |
| 2,4,6-Trichlorophenol       | 26   | 52   | Chrysene                     | 7.9 | 16  |
| 2,4-Dichlorophenol          | 32   | 64   | Coprostanol                  | 28  | 56  |
| 2,4-Dimethylphenol          | 14   | 28   | Dibenzo(a,h)anthracene       | 14  | 28  |
| 2,4-Dinitrotoluene          | 6.0  | 12   | Dibenzofuran                 | 28  | 56  |
| 2,6-Dinitrotoluene          | 20   | 40   | Diethyl Phthalate            | 12  | 24  |
| 2-Chloronaphthalene         | 32   | 64   | Dimethyl Phthalate           | 22  | 44  |
| 2-Chlorophenol              | 16   | 32   | Di-N-Butyl Phthalate         | 10  | 20  |
| 2-Methylnaphthalene         | 28   | 56   | Di-N-Octyl Phthalate         | 16  | 32  |
| 2-Methylphenol              | 38   | 76   | Fluoranthene                 | 16  | 32  |
| 2-Nitrophenol               | 29   | 58   | Fluorene                     | 26  | 52  |
| 4-Bromophenyl Phenyl Ether  | 18   | 36   | Hexachlorobenzene            | 1.3 | 2.6 |
| 4-Chlorophenyl Phenyl Ether | 26   | 52   | Hexachlorobutadiene          | 1.5 | 3.0 |
| 4-Methylphenol              | 32   | 64   | Hexachloroethane             | 29  | 58  |
| Acenaphthene                | 14   | 28   | Indeno(1,2,3-cd)pyrene       | 18  | 36  |
| Acenaphthylene              | 29   | 58   | Isophorone                   | 38  | 76  |
| Aniline                     | 38   | 76   | Naphthalene                  | 28  | 56  |
| Anthracene                  | 7.9  | 16   | Nitrobenzene                 | 32  | 64  |
| Benzo(a)anthracene          | 4.0  | 8.0  | N-Nitrosodimethylamine       | 40  | 80  |
| Benzo(a)pyrene              | 6.0  | 12   | N-Nitrosodi-N-propylamine    | 18  | 36  |
| Benzo(b)fluoranthene        | 6.0  | 12   | N-Nitrosodiphenylamine       | 40  | 80  |
| Benzo(g,h,i)perylene        | 16   | 32   | Pentachlorophenol            | 10  | 20  |
| Benzo(k)fluoranthene        | 6.0  | 12   | Phenanthrene                 | 7.9 | 16  |
| Benzoic Acid                | 12   | 24   | Phenol                       | 18  | 36  |
| Benzyl Alcohol              | 12   | 24   | Pyrene                       | 7.9 | 16  |

The detection limits for the target chlorinated pesticides/PCBs are summarized Table 8. Pesticide/PCB analysis is performed according to EPA methods 3550/8081/8082 (SW 846), which employs solvent extraction with sonication and analysis by gas chromatography/electron capture detector (GC/ECD) with dual column confirmation.

**Table 8 - Chlorinated Pesticide/PCB Target Analytes and Detection Limits**  
(µg/Kg dry weight)

| Analyte         | MDL  | RDL  | Analyte             | MDL  | RDL  |
|-----------------|------|------|---------------------|------|------|
| Aroclor 1016    | 4    | 8    | Delta-BHC           | 0.67 | 1.33 |
| Aroclor 1221    | 8    | 16   | Dieldrin            | 0.67 | 1.33 |
| Aroclor 1232    | 8    | 16   | Endosulfan I        | 0.67 | 1.33 |
| Aroclor 1242    | 4    | 8    | Endosulfan II       | 0.67 | 1.33 |
| Aroclor 1248    | 4    | 8    | Endosulfan Sulfate  | 0.67 | 1.33 |
| Aroclor 1254    | 4    | 8    | Endrin              | 0.67 | 1.33 |
| Aroclor 1260    | 4    | 8    | Endrin Aldehyde     | 0.67 | 1.33 |
| 4,4'-DDD        | 0.67 | 1.33 | Gamma-BHC (Lindane) | 0.67 | 1.33 |
| 4,4'-DDE        | 0.67 | 1.33 | Gamma-Chlordane     | 2.7  | 5.4  |
| 4,4'-DDT        | 0.67 | 1.33 | Heptachlor          | 0.67 | 1.33 |
| Aldrin          | 0.67 | 1.33 | Heptachlor Epoxide  | 0.67 | 1.33 |
| Alpha-BHC       | 0.67 | 1.33 | Methoxychlor        | 3.3  | 6.7  |
| Alpha-Chlordane | 0.67 | 1.33 | Toxaphene           | 6.7  | 13.3 |
| Beta-BHC        | 0.67 | 1.33 |                     |      |      |

## 11.0 Laboratory Quality Assurance/Quality Control

### 11.1 Chemistry

The quality control (QC) samples that will be analyzed in association with the marine sediment chemistry samples are summarized in Table 9. The frequency of method blanks, duplicates, triplicates, and matrix spikes is one per QC batch (20 samples maximum). The frequency of SRM (standard reference material) analysis is one per project (40 samples maximum). Surrogates are analyzed with every organic sample.

**Table 9 - Chemistry Quality Control Samples**

| Analyte       | Method Blank | Duplicate | Triplicate | Matrix Spike | SRM | Surrogates |
|---------------|--------------|-----------|------------|--------------|-----|------------|
| PSD           | No           | No        | Yes        | No           | No  | No         |
| TOC           | Yes          | No        | Yes        | Yes          | Yes | No         |
| Total Solids  | Yes          | No        | Yes        | No           | No  | No         |
| Metals        | Yes          | Yes       | No         | Yes          | Yes | No         |
| BNAs          | Yes          | Yes       | No         | Yes          | Yes | Yes        |
| Cl. Pest./PCB | Yes          | Yes       | No         | Yes          | Yes | Yes        |

The marine sediment chemistry QC limits are shown in Table 10.

**Table 10 - QC Acceptance Limits for Sediment Chemistry Samples**

| Analyte        | Method Blank | Duplicate      | Triplicate     | Matrix Spike | SRM         | Surrogates |
|----------------|--------------|----------------|----------------|--------------|-------------|------------|
| \              |              |                |                |              |             |            |
| PSD            | N/A          | N/A            | RSD $\leq$ 20% | N/A          | N/A         | N/A        |
| TOC            | < MDL        | N/A            | RSD $\leq$ 20% | 75 - 125%    | 80 - 120%   | N/A        |
| Total Solids   | < MDL        | N/A            | RSD $\leq$ 20% | N/A          | N/A         | N/A        |
|                |              |                |                |              |             |            |
| Metals         | < MDL        | RPD $\leq$ 20% | N/A            | 75 - 125%    | $\leq$ 120% | N/A        |
| BNAs           | < MDL        | RPD $\leq$ 35% | N/A            | 50 - 150%    | 80 - 120%   | 50 – 150%  |
| Chl. Pest./PCB | < MDL        | RPD $\leq$ 35% | N/A            | 50 - 150%    | 80 - 120%   | 50 – 150%  |

< MDL - Method Blank result should be less than the method detection limit.

RPD - Relative Percent Difference

RSD - Relative Standard Deviation

N/A - Not Applicable

For Organics QC, the criteria in Tables 10 and 11 are used as informational flags only. Actual method performance (empirically derived) criteria are used, which is required by the Organics reference methods (EPA – The laboratory) derived acceptance limits vary per compound and matrix. These limits are presented in Tables 12-16. Flags applied using criteria from Table 10 are done so with the intent that data users can gain insight, without resorting to a full QC report, as to possible bias and direction of that bias per compound. Quality control results that exceed the acceptance limits will be evaluated to determine appropriate corrective actions. Samples will typically be reanalyzed if the unacceptable QC results indicate a systematic problem with the overall analysis. Unacceptable QC results caused by a particular sample or matrix will not require reanalysis unless an allowed method modification would improve the results. Analytical results that are outside of QC control limits will be qualified and flagged according to quality assurance (QA1) data validation guidance (Ecology 1989). Data qualifier flags and their interpretations are presented in Table 11.



**Table 11 - Data Qualifier Flags and QC Control Limits**

| <b>Condition to Qualify</b>                   | <b>Flag</b> | <b>Organics<br/>Informational<br/>Limits</b> | <b>Metals<br/>QC<br/>Limits</b> | <b>Conventionals<br/>QC Limits</b> |
|---|-------------|--|---------------------------------|------------------------------------|
| Very low matrix spike recovery                | X           | < 10 %                                       | < 10 %                          | < 10 %                             |
| Low matrix spike recovery                     | G           | < 50%  | < 75%                           | < 65 – 75%                         |
| High matrix spike recovery                    | L           | > 150%                                       | >125%                           | > 125 – 135%                       |
| Low SRM recovery                              | G           | < 80%  | N/A                             | < 80%                              |
| High SRM recovery                             | L           | >120%  | >120%                           | >120%                              |
| High duplicate RPD                            | E           | >100 %                                       | >20%                            | N/A                                |
| High triplicate RSD                           | E           | N/A  | N/A                             | > 20%                              |
| Less than the reporting detection limit       | < RDL       | RDL  | RDL                             | RDL                                |
| Less than the method detection limit          | < MDL       | MDL  | MDL                             | MDL                                |
| Contamination in method blank                 | B           | > MDL  | > MDL                           | > MDL                              |
| Very biased data, low surrogate recoveries    | X           | <10%   | N/A                             | N/A                                |
| Biased data, low surrogate recoveries         | G           | < 50%  | N/A                             | N/A                                |
| Biased data, high surrogate recoveries        | L           | >150%  | N/A                             | N/A                                |
| Rejected, unusable for all purposes           | R           |  |                                 |                                    |
| A sample handling criterion has been exceeded | H           |  |                                 |                                    |

Metals data are not qualified based on low SRM recovery since a different digestion method is used.

The average fraction surrogate recovery is used for BNA analysis, both surrogate recoveries are used for pesticide/PCBs.

Sample handling criteria include an exceedence of hold time and incorrect preservation, container, or storage conditions.

**Table 12 - Laboratory QC Limits for Sediment Pesticides and PCBs,  
Matrix Spike Recoveries**

| <b>Parameter</b>    | <b>Lower Limit (%)</b> | <b>Upper Limit (%)</b> |
|---------------------|------------------------|------------------------|
| 4,4'-DDD            | 41                     | 157                    |
| 4,4'-DDE            | 59                     | 125                    |
| 4,4'-DDT            | 50                     | 144                    |
| Aldrin              | 61                     | 119                    |
| Alpha-BHC           | 59                     | 111                    |
| Aroclor 1016        | 43                     | 176                    |
| Aroclor 1260        | 13                     | 198                    |
| Beta-BHC            | 60                     | 119                    |
| Delta-BHC           | 54                     | 126                    |
| Dieldrin            | 60                     | 139                    |
| Endosulfan I        | 64                     | 113                    |
| Endosulfan II       | 36                     | 146                    |
| Endosulfan Sulfate  | 46                     | 113                    |
| Endrin              | 62                     | 166                    |
| Endrin Aldehyde     | 10                     | 66                     |
| Gamma-BHC (Lindane) | 61                     | 135                    |
| Heptachlor          | 52                     | 157                    |
| Heptachlor Epoxide  | 61                     | 118                    |
| Methoxychlor        | 53                     | 129                    |

**Table 13 - Laboratory QC Limits for Sediment Pesticides and PCBs,  
Blank Spike Recoveries**

| <b>Parameter</b>    | <b>Lower Limit (%)</b> | <b>Upper Limit (%)</b> |
|---------------------|------------------------|------------------------|
| 4,4'-DDD            | 78                     | 121                    |
| 4,4'-DDE            | 75                     | 111                    |
| 4,4'-DDT            | 57                     | 145                    |
| Aldrin              | 28                     | 113                    |
| Alpha-BHC           | 20                     | 99                     |
| Aroclor 1016        | 35                     | 111                    |
| Aroclor 1260        | 47                     | 146                    |
| Beta-BHC            | 66                     | 102                    |
| Delta-BHC           | 63                     | 108                    |
| Dieldrin            | 58                     | 139                    |
| Endosulfan I        | 62                     | 104                    |
| Endosulfan II       | 72                     | 109                    |
| Endosulfan Sulfate  | 61                     | 104                    |
| Endrin              | 60                     | 160                    |
| Endrin Aldehyde     | 0                      | 77                     |
| Gamma-BHC (Lindane) | 27                     | 130                    |
| Heptachlor          | 20                     | 137                    |
| Heptachlor Epoxide  | 59                     | 107                    |
| Methoxychlor        | 72                     | 131                    |

**Table 14 - Laboratory QC Limits for Sediment BNAs,  
Matrix Spike Recoveries**

| <b>Parameter</b>            | <b>Lower<br/>Limit (%)</b> | <b>Upper<br/>Limit (%)</b> | <b>Parameter</b>            | <b>Lower<br/>Limit (%)</b> | <b>Upper<br/>Limit (%)</b> |
|-----------------------------|----------------------------|----------------------------|-----------------------------|----------------------------|----------------------------|
| 1,2,4-Trichlorobenzene      | 10                         | 115                        | Benzo(g,h,i)perylene        | 10                         | 173                        |
| 1,2-Dichlorobenzene         | 10                         | 105                        | Benzo(k)fluoranthene        | 10                         | 192                        |
| 1,2-Diphenylhydrazine       | 16                         | 162                        | Benzoic Acid                | 10                         | 158                        |
| 1,3-Dichlorobenzene         | 10                         | 103                        | Benzyl Alcohol              | 10                         | 138                        |
| 1,4-Dichlorobenzene         | 10                         | 104                        | Benzyl Butyl Phthalate      | 41                         | 145                        |
| 2,4,5-Trichlorophenol       | 23                         | 166                        | Bis(2-Chloroethoxy)Methane  | 23                         | 103                        |
| 2,4,6-Trichlorophenol       | 26                         | 153                        | Bis(2-Chloroethyl)Ether     | 10                         | 80                         |
| 2,4-Dichlorophenol          | 24                         | 142                        | Bis(2-Chloroisopropyl)Ether | 10                         | 142                        |
| 2,4-Dimethylphenol          | 10                         | 150                        | Bis(2-Ethylhexyl)Phthalate  | 10                         | 189                        |
| 2,4-Dinitrophenol           | 18                         | 134                        | Caffeine                    | 17                         | 195                        |
| 2,4-Dinitrotoluene          | 27                         | 166                        | Carbazole                   | 16                         | 200                        |
| 2,6-Dinitrotoluene          | 10                         | 183                        | Chrysene                    | 14                         | 184                        |
| 2-Chloronaphthalene         | 26                         | 111                        | Coprostanol                 | 10                         | 183                        |
| 2-Chlorophenol              | 10                         | 112                        | Di-N-Butyl Phthalate        | 10                         | 194                        |
| 2-Methylnaphthalene         | 22                         | 112                        | Di-N-Octyl Phthalate        | 52                         | 151                        |
| 2-Methylphenol              | 10                         | 142                        | Dibenzo(a,h)anthracene      | 10                         | 166                        |
| 2-Nitroaniline              | 62                         | 89                         | Dibenzofuran                | 21                         | 134                        |
| 2-Nitrophenol               | 20                         | 107                        | Diethyl Phthalate           | 31                         | 150                        |
| 3,3'-Dichlorobenzidine      | 10                         | 43                         | Dimethyl Phthalate          | 13                         | 162                        |
| 3-Nitroaniline              | 10                         | 52                         | Fluoranthene                | 12                         | 188                        |
| 4,6-Dinitro-O-Cresol        | 40                         | 145                        | Fluorene                    | 22                         | 147                        |
| 4-Bromophenyl Phenyl Ether  | 30                         | 146                        | Hexachlorobenzene           | 18                         | 151                        |
| 4-Chloro-3-Methylphenol     | 48                         | 132                        | Hexachlorobutadiene         | 10                         | 97                         |
| 4-Chloroaniline             | 10                         | 49                         | Hexachlorocyclopentadiene   | 10                         | 117                        |
| 4-Chlorophenyl Phenyl Ether | 25                         | 139                        | Hexachloroethane            | 10                         | 89                         |
| 4-Methylphenol              | 10                         | 163                        | Indeno(1,2,3-Cd)Pyrene      | 10                         | 177                        |
| 4-Nitroaniline              | 10                         | 88                         | Isophorone                  | 16                         | 130                        |
| 4-Nitrophenol               | 45                         | 153                        | N-Nitrosodi-N-Propylamine   | 10                         | 176                        |
| Acenaphthene                | 25                         | 130                        | N-Nitrosodimethylamine      | 10                         | 119                        |
| Acenaphthylene              | 27                         | 132                        | N-Nitrosodiphenylamine      | 10                         | 169                        |
| Aniline                     | 10                         | 67                         | Naphthalene                 | 12                         | 97                         |
| Anthracene                  | 10                         | 181                        | Nitrobenzene                | 10                         | 105                        |
| Benzidine                   | 10                         | 200                        | Pentachlorophenol           | 17                         | 170                        |
| Benzo(a)anthracene          | 32                         | 168                        | Phenanthrene                | 10                         | 200                        |
| Benzo(a)pyrene              | 10                         | 200                        | Phenol                      | 10                         | 127                        |
| Benzo(b)fluoranthene        | 10                         | 199                        | Pyrene                      | 20                         | 174                        |

**Table 15 - Laboratory QC Limits for Sediment BNAs,  
Blank Spike Recoveries**

| <b>Parameter</b>            | <b>Lower<br/>Limit (%)</b> | <b>Upper<br/>Limit (%)</b> | <b>Parameter</b>            | <b>Lower<br/>Limit (%)</b> | <b>Upper<br/>Limit (%)</b> |
|-----------------------------|----------------------------|----------------------------|-----------------------------|----------------------------|----------------------------|
| 1,2,4-Trichlorobenzene      | 13                         | 110                        | Benzo(g,h,i)perylene        | 46                         | 126                        |
| 1,2-Dichlorobenzene         | 10                         | 116                        | Benzo(k)fluoranthene        | 58                         | 128                        |
| 1,2-Diphenylhydrazine       | 32                         | 125                        | Benzoic Acid                | 10                         | 170                        |
| 1,3-Dichlorobenzene         | 18                         | 95                         | Benzyl Alcohol              | 10                         | 119                        |
| 1,4-Dichlorobenzene         | 21                         | 99                         | Benzyl Butyl Phthalate      | 15                         | 183                        |
| 2,4,5-Trichlorophenol       | 33                         | 113                        | Bis(2-Chloroethoxy)Methane  | 19                         | 103                        |
| 2,4,6-Trichlorophenol       | 27                         | 98                         | Bis(2-Chloroethyl)Ether     | 18                         | 82                         |
| 2,4-Dichlorophenol          | 24                         | 103                        | Bis(2-Chloroisopropyl)Ether | 10                         | 104                        |
| 2,4-Dimethylphenol          | 10                         | 81                         | Bis(2-Ethylhexyl)Phthalate  | 10                         | 182                        |
| 2,4-Dinitrophenol           | 10                         | 149                        | Caffeine                    | 45                         | 159                        |
| 2,4-Dinitrotoluene          | 35                         | 148                        | Carbazole                   | 44                         | 179                        |
| 2,6-Dinitrotoluene          | 46                         | 110                        | Chrysene                    | 69                         | 111                        |
| 2-Chloronaphthalene         | 25                         | 96                         | Coprostanol                 | 10                         | 159                        |
| 2-Chlorophenol              | 10                         | 102                        | Di-N-Butyl Phthalate        | 17                         | 180                        |
| 2-Methylnaphthalene         | 22                         | 99                         | Di-N-Octyl Phthalate        | 10                         | 200                        |
| 2-Methylphenol              | 16                         | 91                         | Dibenzo(a,h)anthracene      | 53                         | 129                        |
| 2-Nitroaniline              | 57                         | 95                         | Dibenzofuran                | 37                         | 97                         |
| 2-Nitrophenol               | 21                         | 98                         | Diethyl Phthalate           | 51                         | 118                        |
| 3,3'-Dichlorobenzidine      | 18                         | 86                         | Dimethyl Phthalate          | 38                         | 114                        |
| 3-Nitroaniline              | 34                         | 72                         | Fluoranthene                | 55                         | 132                        |
| 4,6-Dinitro-O-Cresol        | 18                         | 157                        | Fluorene                    | 39                         | 106                        |
| 4-Bromophenyl Phenyl Ether  | 47                         | 113                        | Hexachlorobenzene           | 40                         | 111                        |
| 4-Chloro-3-Methylphenol     | 50                         | 105                        | Hexachlorobutadiene         | 10                         | 97                         |
| 4-Chloroaniline             | 10                         | 57                         | Hexachlorocyclopentadiene   | 10                         | 109                        |
| 4-Chlorophenyl Phenyl Ether | 39                         | 101                        | Hexachloroethane            | 17                         | 92                         |
| 4-Methylphenol              | 10                         | 125                        | Indeno(1,2,3-Cd)Pyrene      | 51                         | 132                        |
| 4-Nitroaniline              | 45                         | 130                        | Isophorone                  | 10                         | 131                        |
| 4-Nitrophenol               | 40                         | 170                        | N-Nitrosodi-N-Propylamine   | 10                         | 146                        |
| Acenaphthene                | 29                         | 102                        | N-Nitrosodimethylamine      | 14                         | 101                        |
| Acenaphthylene              | 31                         | 101                        | N-Nitrosodiphenylamine      | 11                         | 148                        |
| Aniline                     | 10                         | 102                        | Naphthalene                 | 17                         | 94                         |
| Anthracene                  | 45                         | 114                        | Nitrobenzene                | 10                         | 112                        |
| Benidine                    | 10                         | 200                        | Pentachlorophenol           | 38                         | 124                        |
| Benzo(a)anthracene          | 69                         | 117                        | Phenanthrene                | 57                         | 104                        |
| Benzo(a)pyrene              | 15                         | 137                        | Phenol                      | 10                         | 107                        |
| Benzo(b)fluoranthene        | 50                         | 121                        | Pyrene                      | 48                         | 132                        |

**Table 16 - Laboratory QC Limits for Sediment BNAs,  
Surrogate Recoveries**

| <b>Parameter</b>       | <b>Lower Limit (%)</b> | <b>Upper Limit (%)</b> |
|------------------------|------------------------|------------------------|
| 2,4,6-Tribromophenol   | 29                     | 112                    |
| 2-Fluorophenol         | 10                     | 112                    |
| d5-Phenol              | 10                     | 106                    |
| d5-Nitrobenzene        | 28                     | 94                     |
| d4-2-Chlorophenol      | 11                     | 105                    |
| d4-1,2-Dichlorobenzene | 24                     | 91                     |
| 2-Fluorobiphenyl       | 31                     | 101                    |
| d14-Terphenyl          | 51                     | 130                    |

## **11.2 Data Reporting and Record Keeping**

The King County Environmental Laboratory will provide a 90-day turnaround time for all chemistry analytical data, starting upon receipt of the last sample collected. The only exception will be the PCB analysis of certain sediments for choosing the appropriate disposal method. These samples will be completed and reported within 24 hours of receipt at the lab. All data received from subcontract laboratories will be reported to the King County Environmental Laboratory in a format, which includes QC summaries. These summaries will then be reviewed and qualified as appropriate.

## **11.3 Chemistry Data**

All chemistry data will be reported in a QA1 report and a QA2 data validation package (Ecology, 1989). The final report package will contain the following information and deliverables:

- a QA1 narrative discussing data quality in relation to Wash. State Sediment Quality data qualification criteria (SEDQUAL);
- a summary of all associated QC data summaries (LIMS QC reports and worklists);
- a comprehensive report containing all analytical and field data (including data qualifier flags) and,
- A full QA2 data validation package including sample preparation logs, instrument analysis logs, instrument quantification reports with reconstructed ion chromatograms and detected compound mass spectral graphs, initial and continuing calibration tables and instrument performance compound summaries.

## **11.4 SEDQUAL Files**

The chemistry analysis data will be reported in SEDQUAL format for eventual delivery to Ecology.

### **11.5 Record Keeping**

All field and sampling records, custody documents, raw lab data, and summaries and narratives will be archived according to King County Environmental Laboratory policy.

## **12.0 Project Health and Safety**

The following general health and safety guidelines have been provided in lieu of a site-specific Health and Safety Plan. These guidelines will be read and understood by all members of the sampling crew.

- All crew of a research or safety vessel will have received annual vessel safety training, which will include proper chain of communication, equipment operation, and safe boating practices.
- Samplers will wear chemical-resistant gloves whenever coming into contact with sediment.
- No eating or drinking by sampling personnel will be allowed during sampling operations.
- All sampling operations will be conducted during daylight hours.
- All accidents, 'near misses,' and symptoms of possible exposure will be reported to a sampler's supervisor within 24 hours of occurrence.
- All crew members will be aware of the potential hazards associated with any chemicals used during the sampling effort.

Several hazards are inherent to marine sediment sampling. General vessel safety, physical hazards unique to sediment grab sampling and chemical hazards are discussed in sections 12.1 through 12.3.

### **12.1 General Vessel Safety**

To help prevent accidents and ensure adequate preparation for emergencies that may possibly arise, the following safety equipment will be required on the *Liberty*:

- one personal floatation device for each crew member as well as at least one throwable floatation device;
- an accessible, clearly labeled, fully stocked first-aid/CPR kit;
- an accessible and clearly labeled eye wash;
- one (preferably two) VHF marine radio(s) with weather channel;
- a cellular telephone;
- a horn;
- navigation lights;
- an emergency life raft with oars or paddles;
- an anchor and suitable line;
- signal flares; and
- a reach pole or shepherd's hook.

Personal protective equipment will be selected and used that will protect workers involved in sediment sampling from the hazards and potential hazards likely to be encountered. Minimum required personal protective equipment for marine sediment sampling shall include the following:

- hard hat;
- steel-toe rubber boots;
- chemical-resistant gloves (i.e. Nitrile); and
- safety glasses (safety glasses will be available for use if sediment characteristics indicate the possible presence of hazardous chemicals; i.e., sheen or petroleum/solvent odor).

Recommended additional personal protective equipment will include rain gear and hearing protection when on board the *Liberty*.

## **12.2 Grab Sampling**

Sampler deployment and sediment retrieval present physical hazards due in part to the heavy weight of the grab sampler, its suspension above the vessel deck, and the risk of accidental or premature closure. Prior to each sampling event, all cabling, shackles, pins, housings, and swivels will be inspected to ensure the integrity of all points along the sampling assembly.

The sampler will always be set while it is resting on a stable surface. Once set, a safety pin will be set in place on the triggering mechanism and remain in place until the sampler is swung outboard of the vessel rail. Special care will be exercised when removing the safety pin to ensure personal safety in the event of a gear or winch failure. Fingers will not be placed through the ring of the pin when it is removed and hands will be kept completely clear of the sampler interior after the pin has been removed. If a sampler is retrieved that has not been tripped, it will be lowered to a stable surface before any worker contact.

During grab retrieval, one crew member will watch for the appearance of the grab sampler and alert the winch operator when the sampler is first visible below the water surface. Attempting to bring a swinging grab sampler on board poses a serious risk of being hit or knocked overboard. The winch operator will minimize swinging before the grab sampler is brought on board for the crew to secure. Hard hats and gloves will always be worn when handling the grab sampler.

The winch drum, blocks, capstan, and any area between the grab sampler and railings, the deck, and heavy equipment all represent significant pinching and crushing hazards. Only experienced crew members will operate the winch or capstan during a sampling event. Other crewmembers will exercise care to avoid these potentially hazardous areas.

## **12.3 Chemical Hazards**

Contact with marine sediment at some sampling stations may present a health hazard from chemical constituents of the sediment. Potential routes of exposure to chemical

hazards include inhalation, skin and eye absorption, ingestion, and injection. Crew members will exercise caution to avoid coming into contact with sediment at all stations during sampling operations. Protective equipment will include chemical-resistant gloves, safety glasses or goggles, and protective clothing (i.e. rain gear). Crew members will exercise good personal hygiene after sampling and prior to eating or drinking.

## 13.0 References

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EBDRP 2001. Duwamish/Diagonal CSO/SD Cleanup Study Report, prepared for the Elliott Bay/Duwamish Restoration Program Panel, by King County, Anchor Environmental and Ecochem, Panel publication 30, December 2001.

Ecology 2002. Sediment Management Standards Cleanup Action Decision: Duwamish/Diagonal CSO/SD, July 25, 2002.

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